PATENT SPECIFICATION

1,023,178

1,023,178

Date of Application and filing Complete Specification: August 4, 1964.

No. 30801/64

Application made in United States of America (No. 297852) on July 26, 1963.

Complete Specification Published: March 23, 1966.

Index at Acceptance:—**B1** D (1A, 1B1, 1D, 1E, 1G, 2J1B2, 2J1C3, 2J1D, 2K1).

Int. Cl.:—B 01 d.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements relating to Filters

We, WINSLOW ENGINEERING AND MANUFACTURING Co., a Corporation organised and existing under the laws of the State of California, United States of America, of 1093 Charter Street, Redwood City, California, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to filtering units for purifying fluids, and more particularly it relates to an improved dual element filter unit for removing sludge, grit, and other deleterious matter from lubricating oil employed in a circulating oil system of an internal combustion engine, or other mechanism having similar requirements.

Filtering units for lubricating oil to which the invention is especially applicable are those types comprising a housing into which oil to be filtered may be continuously introduced through one conduit and from which filtered oil may be continuously removed through another conduit, a suitable filtering material being disposed within the housing in the path of the oil flowing therethrough for removing filterable material from the oil. The filtering material in such units usually comprises a mixture of fibrous and porous materials retained in an annular shaped package of substantial length and confined by either a flexible hollow casing of porous knitted fabric, or perforated metal wall member. Examples of suitable filtering material are spun cotton, natural and synthetic fibres, wood fibres, and other natural fibres such as sisal or hemp. In addition, various chemicals that are not soluble in oil and do not react with the chemical compounds used in detergent type oils, may be mixed with the fibrous materials to form a permanent, homogeneous part of the filter element. Other types of filtering media may be used such as pleated paper, and although the annular shape is more commonly used, such filtering elements may be constructed in a variety of shapes adapted to fit into different types of housings.

Filtering units of the aforesaid type are most commonly connected in oil circulation systems in either a shunt type or a "full flow" filtering system. In a shunt type system only a portion of the total oil circulated flows through the filtering unit, and any interruption or restriction of this flow by the filter in no way hinders the passage of unfiltered oil to the surfaces to be lubricated. The "full flow" type of system is more effective in filtering since all of the circulating oil is filtered on every cycle. However, in such a system any interruption or restriction of the flow through the filtering unit causes a corresponding reduction in the rate at which the oil is supplied to the surfaces to be lubricated. Maximum filtering effectiveness is, of course, achieved when the filter element is comprised of a relatively fine media, thereby enabling it to remove a high percentage of sludge, grit and other deleterious substances. Yet, the filtering media must be and remain sufficiently porous as a whole, to permit the amount of oil flow through the filter that is necessary to supply the surfaces being lubricated. There are many instances in normal engine operation where the oil will not readily flow through a fine media filtering element at the necessary flow rate, such as during cold starts or because of partial clogging of the element. It has long been the practice in "full flow" filters to provide a means for bypassing the oil completely around the filtering element when adequate flow through them cannot be maintained. However, bypassing of unfiltered oil is not

[Price

desirable because it partially or completely eliminates any filtering action and thus allows deleterious substances in the oil to flow directly back to the oil supply sump of the engine. The amount of bypassing of a filter which is necessary can be decreased by increasing the coarseness and hence the porosity of the filter media. This compromise reduces the overall efficiency of the filtering unit under normal operating conditions. The general problem then, prior to the present invention, was to provide a filtering unit capable of providing a high filtering efficiency without bypassing of oil over a wide range of operating conditions.

One effort in solving the aforesaid problem was described in an earlier U.S. Patent No. 2,559,267. There a dual element filter was utilised wherein one of the filter elements was composed of a relatively fine filtering medium and the other element was composed of a relatively coarse medium. The two filter media were enclosed within a single housing and arranged so that under conditions of higher pressure where oil could not pass freely through the fine medium, it would still be able to pass readily through the coarser medium. This arrangement prevented the complete bypassing of oil being filtered under these extreme pressure conditions. However, one problem with the aforementioned filtering arrangement was that even under the normal pressure conditions a substantial portion of the oil being filtered travelled through the coarser medium. Therefore, the total amount of oil passing through the unit was not being filtered by the finer medium and the overall filtering efficiency of the unit was not maintained at its maximum level. Moreover, as the finer medium element began to clog up and offer more resistance to flow, the oil was easily diverted to the coarser and less effective filter element.

According to the invention there is provided a filtering unit comprising a first filter element of relatively fine filter material and a second filter element of relatively coarse filter material, and valve means so arranged as normally to control the fluid to be filtered to pass through the first element, and to pass fluid through the second element when the pressure-drop through the first element exceeds a predetermined value.

The invention further provides for a bypass valve arrangement which may come into operation if both fine and coarse filter elements become clogged.

The invention also includes constructional features, which are described below in respect of examples, and which are defined in the appended claims.

Other objects, advantages and features of the invention will become apparent from the following detailed description, and as shown in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of one form of filtering unit made in accordance with the invention;

Fig. 2 is a fragmentary plan view of the annular spring disc for the drainback valve of the filtering unit of Fig. 1;

Fig. 3 is a vertical sectional view of another form of filtering unit embodying principles of the present invention;

Fig. 4 is a fragmentary view in section of the filtering unit of Fig. 3 showing its inlet.

Referring to the drawings, Fig. 1 shows an oil filtering unit 10 of the full flow type embodying the principles of the invention and particularly well adapted for use in lubricating oil systems of engines or other mechanisms requiring a relatively low but constant flow of oil to various surfaces subject to wear. As shown, the unit 10 is of the fully sealed screw-on type that may be thrown away and replaced when its filtering efficiency has been reduced after long use. It is removably connected to a combined inlet and outlet fitting 11 for an engine lubrication system which fitting includes a central conduit 12 for receiving the outlet flow of clean filtered oil from the unit 10, and an outer conduit member 13 forming an annular passage 14 for carrying the inlet flow of presumably dirty unfiltered oil into the filtering unit 10. The filter unit 10 is secured to the fitting 11 by means of an upwardly extending externally threaded boss portion 15 of the wall of the conduit 12. Other inlet and outlet connections and other means for attaching the unit 10 to an engine could obviously be utilised.

As shown in Fig. 1, the filtering unit 10 comprises a relatively thick base member 16 having a central upwardly extending and internally threaded tubular boss portion 17 adapted to engage the threaded boss portion 15 on the fitting 11. The base member 16 is downwardly depressed slightly around the tubular portion 17 and spaced around it in the depressed area is a series of inlet ports 18 into which oil can flow from the annular inlet conduit 14. Extending above and around the base member 16 is a cylindrical metal housing 19 having an integral top portion 20 at its upper end. At its lower end the housing is crimped by means of a seal joint 21 to an annular retainer plate member 22. The latter supports the base member 16 within the housing 19 and has a pair of spaced apart ridges 23 spaced radially inwardly from its crimped edge 21 which form a circular groove for retaining a resilient gasket 24 that seals the unit 10 against the inlet and outlet fitting 11. Fixed within the sealed housing 19 is a cylindrical filtering cartridge 25 which will be described hereinafter in greater detail.

The filter cartridge 25, as shown in Fig. 1, has a smaller diameter than, and is fixed

in position within, the housing 19 so that unfiltered oil can flow through the bottom inlet ports 18, past an anti-drainback valve member 26 and into an annular space 27 around the cartridge 25. In accordance with the invention the cartridge 25 includes two annular shaped filtering elements 28 and 29 each of which has a filtering media of different porosities. The first element 28 has a finer filter medium of any suitable well known type such as wood, cotton fibres or pleated paper, and is capable of removing finer particles (e.g. of width 10 microns). It performs the entire filtering function of the unit 10 under normal operating conditions until it becomes saturated with debris and deposits and clogs up, thereby increasing its resistance to flow and thus the pressure in the annular space 27. The second element 29 is made of a coarser filter medium capable of filtering only larger sized particles (e.g. of width 50 microns). However, the oil does not flow through it until a predetermined pressure drop through the first element 28 has been reached, at which point the second element 29 automatically becomes operative.

In the unit 10 shown in Fig. 1, the two annular shaped filter elements 28 and 29 are axially aligned in an end-to-end arrangement within an outer cylindrical wall member 30. The wall member 30 may be of metal, plastic or any other suitable material and it is perforated to allow for the passage of oil therethrough. Crimped by a peripheral sealing joint 31 to the upper end of the wall member 30 is an impervious end cap 32 of sheet metal. A centrally located circular depression 33 in the cap 32 serves to retain one end of a coil spring 34 seated at its other end against the top 20 of the housing 10 and thereby holding the filter cartridge firmly in position within the housing 19. At its lower end the cartridge 25 has an annular end wall 35, also connected by means of a crimped peripheral joint 36 at its outer edge to the wall member 30. Around its inner edge the wall 35 has an upwardly extending flange portion 37. At the lower end of the cartridge 25 the bottom wall 35 is engaged by a bypass valve assembly 38 which supports the cartridge 25 axially while keeping it centered within the housing 19 and spaced upwardly from the base plate 16 when the unit 10 is assembled.

The first filter element 28 having a relatively fine filter medium is separated from the second coarser filter element 29 by an annular plate 39. Extending above the plate 39 is an inner tubular and perforated wall member 40 having an inwardly extending flange 41 at its lower end engaging the plate 39 and forming a cylindrical chamber 42. Below the plate 39 is a similar perforated tubular wall member 43 forming a somewhat larger cylindrical chamber 44 within the cartridge 25. The lower wall member 43 is connected at its lower end to the inner flange portion 37 of the cartridge bottom wall 35 adjacent the bypass valve 38. The annular plate 39 has a central opening 45 having an upwardly and inwardly slanted circular flange 46 around its edge. Attached to the underside of the annular plate 39 and extending downwardly therefrom within the cavity 44 is an inverted cup-shaped member 47 with an inwardly turned flange 48 at its lower end around an opening, the flange forming a seat for supporting a coil valve spring 49. Fixed to the upper end of the coil spring 49 is a movable dome-shaped valve member 50 which is normally urged upwardly by the spring 49 into sealing engagement with the inner circular flange 46 of the annular plate 39, the valve member 50 being movable downwardly in response to an increase in the pressure differential between the upper chamber 42 within the element 29 and the lower chamber 44 within the element 28. When this pressure differential increases due to the failure of the oil to flow freely through the first element 28, the valve member 50 will be forced downward, thereby allowing oil to flow through the second filter element 29 of coarser filter material into the chamber 42, down through the lower chamber 44 and out the outlet 12 to the surfaces being lubricated.

Within the lower end of the housing 19 the bypass valve shown as an assembly 38 functions to divert oil directly from the annular inlet passage 14 to the outlet conduit 12 if it becomes impossible for oil to flow adequately through the elements 28 or 29 of the filtering cartridge 25. As shown, the bypass valve assembly 38 comprises an annular plate member 51 having an inner tubular flange 52 that fits tightly around the upper end of the tubular portion 17 of the base member 16. Connected to the annular member 51 around its outer edge is the lower end flange 55 of an upwardly extending cup-shaped member 56 having a circular cross section and a tapered upper portion 57 that extends above the annular plate member 51 and into the chamber 44 of the filter element 28. Circumferentially spaced apart in the fixed annular member 51 around the tubular portion 17 are a series of ports 58. These ports 58 are normally blocked by a movable annular closure member 59 preferably made of a resilient material and having an upwardly extending flange 60 around its inner edge. Embedded in the upper side of the closure member 59 is a metal reinforcing ring 61 having an upright inner flange. A compression spring 62 is seated on the metal ring 61 at its lower end and at its upper end is retained by an inwardly extending flange 63 at the upper end of the member 56. Thus, the spring 62 constantly urges the closure member 59 downwardly against the annular

plate member 51 to keep the bypass ports 58 closed during normal operation of the filter. However, when the pressure within the filter housing 19 increases to a predetermined high level due to complete clogging of the cartridge 25, the annular closure member 59 will be forced upwardly against the force of the spring 62 to allow oil to flow through the ports 58 directly into the outlet 12.

In combination with the bypass valve 38, the filtering unit 10 is also provided with the anti-drainback valve 26 which prevents any reverse flow of oil through the inlet passages 14 when no oil is being supplied to the filter 10 under pressure. As shown in Fig. 1, the valve 26 is retained around the tubular member 17 on the end base plate 16 by the inner flange 52 of the annular member 51. The flange 52 is engaged with a washer 64 disposed adjacent the inner edge of an annular spring disc retaining member 65. The latter, which is made of a thin resilent sheet metal material, extends around the tubular 17 and covers a lower annular gasket member 66 of resilient or flexible material. Another washer 67 is located just below the inner edge of the member 66 so that near its inner portion the member 66 is spaced slightly away from the base plate 16. The outer portion of the annular member 66 extends radially outwardly over the inlet ports 18 and is held against the base member 16 by the annular retaining member 65. The latter member exerts a downward force tending to close the annular member 66 against the base member 16 so as to close the ports 18 by means of a series of circumferentially spaced apart prongs 68 that are integral with the member 65 at one end. The prongs 68 extend inwardly and upwardly, their free ends being adapted to engage the annular member 51, thereby causing the retaining member 65 to press the annular sealing member 66 against the base member 16. The amount of force supplied by the prongs 68 is, of course, small so that they readily yield to permit flow through ports 18 during normal operation of the filter. In Fig. 2, the prongs 68 are shown as being straight and extending upwardly and radially inwardly toward the centre of the member 65. However, they could also be curved and extend inwardly in a helix-like pattern. At their inner ends the prongs have a bent portion 60 adapted to form a secure engagement with the annular member 51.

Reviewing now the operation of the filtering unit 10, the dirty oil is first forced through the ports 18 in the base member 16, through the anti-drainback valve member 26 and into the annular space 27 around the dual element wall member 30. When the elements 28 and 29 are new and the viscosity of the oil is normal, the dome-like valve member 50 is normally pressed tightly by the spring 49 into firm sealing engagement with the flange 46 of the separator plate 39. Thus, the oil entering the unit 10 flows only through the first filter element 28 having the fine filtering medium. After considerable use when the first filter element 28 gradually becomes clogged with the dirt, debris and deposits filtered from the passing oil, or in instances when the oil is cold and viscous, the oil pressure within the housing 19 will rise. When the pressure drop across the first element 28, that is, when the pressure of the oil in the chamber 42 above the annular plate 39 reaches a predetermined level (e.g. 5 to 6 psi), the valve member 50 will move downward against the spring 49 and away from the flange 46 of the opening 45 in the plate 39, thus bringing the second filter element 29 into operation by allowing oil to flow through it from the outside annular passage 27.

In addition to the throw-away or "disposable" type filter unit 10 which has just been described, the present invention may also be applied to filters wherein only the cartridge is disposable, which filters are preferable for certain applications. A filter unit 10*a* having such a construction is shown in Figs. 3 and 4. In this embodiment, the housing 19*a* comprises a lower housing member 70 removably attached to an upper housing member 71 by a clamp 72 with a sealing gasket 73 between the two housing members. Near the upper end of the lower housing member 70 is fixed an inlet fitting 74 which directs the inlet oil tangentially into the filter unit 10*a*, as shown in Fig. 4. The outlet for clean filtered oil is provided by a fitting 75 at the lower end of the lower housing member 70.

Within the connected housing members 70 and 71 are mounted a pair of filter elements 28*a* and 29*a*. The largest of the elements 28*a* is made up of relatively fine filtering medium such as the various well known fibrous materials which are enclosed in a member 76 of a pervious knitted fabric having an annular shape. The smaller filter element 29*a* has generally the same construction as the larger element except that its knitted covering 77 is filled with coarser filter medium. Separating the filter elements 28*a* and 29*a* is an impervious transverse annular plate 39*a* having an outer diameter equal to or greater than the elements 28*a* and 29*a* and an open ended downwardly extending cup-shaped centre section 47*a* with an annular flange 48*a*. Spot welded to the plate 39*a* is an annular valve seat member 78 having an upturned inner flange 41*a* forming the periphery of central opening 45*a*. A coil spring 49*a* is seated at one end on the annular flange 48*a* and its other end is fixed to a dome-shaped valve member 50*a* having a maximum diameter larger than the opening 45*a*. The spring normally forces the

valve member into the opening 45*a* so that it seals around the flange 41*a*, but the valve member will move downwardly to permit flow through the opening 45*a* when the pressure above it within the secondary element 29*a* exceeds the pressure below it within the larger primary element 28*a* by a predetermined amount, a condition that occurs when the primary element becomes clogged. The larger element 28*a* has a perforated inner tube 43*a* extending axially through its centre which provides a cylindrical chamber 44*a* below the annular plate 39*a*. A similar perforated tube section 40*a* is inserted in the smaller element 29*a* to form a chamber 42*a* above the plate 39*a*.

Adjacent to the lower end of the larger primary element 28*a* is a supporting formed end plate 80 with a central opening 81 having an inwardly and upwardly bent flange 82. The opening 81 is slightly larger than and is therefore adapted to fit around a tubular member 83 fixed to the outlet fitting 75 and extending axially into the chamber 44*a* of the primary element 28*a*. Within the annular recess formed by the flange 82 is an annular resilient gasket seal member 84. The seal is held in place by a washer 85 that is pressed against the end plate 80 by a coil spring 86 seated on an internal shoulder of the outlet fitting 75. The end plate 80 is formed to include a perforated annular flange 87 whose outer edges are curved downwardly and outwardly toward the walls of the housing 19*a*. The member 80 is provided with a series of openings 88 circumferentially spaced apart near its periphery which provide access to a trap space 89 at the bottom of the housing 19*a* for retaining sludge and the heavier solids removed from the oil and for preventing them from being constantly recirculated by the agitated oil within the housing. The outer rim of the flange 87 is preferably slightly spaced from the shell 19*a* of the filtering unit 10*a*.

The upper end of the smaller or secondary filter element 29*a* is retained by a cylindrical cup-shaped end member 90 on which is centrally mounted a bypass valve assembly 38*a*. The end member 90 has a central opening 91 that is surrounded by an upturned flange 92. Spot welded to the end member around its central opening 91 is a downwardly extending cup-shaped retaining member 93 that extends axially into the chamber 42*a* and is provided with an inwardly turned flange 94 for retaining one end of a bypass valve spring 95. The upper end of the spring 95 is fixed into a dome-shaped valve member 96 which is normally urged into sealing engagement with the flange 92. When the pressure in the space 97 above the secondary element 29*a* exceeds a predetermined amount, the oil within the unit 10*a* will bypass both elements and pass through the openings 91 and 45*a*, leaving the unit 10*a* through the outlet 75.

The end member 90 has a short cylindrical vertical wall portion 98 to which is connected a cylindrical magnesium shell member 99 which extends downwardly to a point near the lower end of the primary filter element 28*a* and is situated approximately midway between the housing 19*a* and the outer surface of the elements 28*a* and 29*a*. The general function of this shell member 99 is to provide a substantially circular flow pattern for the incoming oil that centrifugally separates any air from the oil and allows it to escape before the oil flows through the element 28*a* or 29*a*. It also serves to reduce any turbulence due to the oil flow directly adjacent the elements. At its lower end near the bottom of the element 28*a* the shell member 99 has an outwardly flared portion 100 extending toward the housing wall. This creates a restricted annular passage 101 which speeds up the flow of oil around the lower edge of the shell member 99 and also helps to separate the oil from any large solid particles which can thus flow through the openings 88 into the sump trap 89.

At the lower end of its vertical wall portion 98 the end member 90 has a series of radially outwardly extending rectangular shaped projections 102 along its periphery (see Fig. 4). These projections 102 are adapted to fit into slightly larger openings 103 between projections 105 that are circumferentially spaced apart along a flange of a member 104 fixed to the inner wall of the lower housing portion 70, thereby providing a bayonet locking system. The assembled filter elements 28*a* and 29*a* with their valve components assembled as described, can be easily inserted by extending them axially into the lower housing member 70 and a small twist to the end member will lock them axially in place. The spring 86 serves to press the engaged projections 102 and 105 together to hold the assembled elements 28*a* and 29*a* firmly in position within the housing. When the elements are locked in place the openings 103 between the engaged bayonet projections allow oil or air to pass upwardly into the space 97.

At the upper end of the upper housing member 71 is a fitting 106 with a controlled restricted orifice providing a vent for releasing air from the filter, and at the lower end of the device 10*a* is a liquid drain fitting 107. The vent 106 is particularly important when the filter unit 10*a* is used for filtering heavily aerated oil such as may occur with some types of engine or in some circumstances. Before such oil can be effectively filtered, it is desirable that air be removed. As a means of trapping and removing the air from the filter unit 10*a* an internal plate 110 is provided inside the housing 71 near its upper end. This plate 110 is preferably

spot welded to the housing wall around its periphery as shown at 111, and near its edge are a large number of small (e.g. 1/32 inch diameter) spaced apart orifices 112. Under normal operating pressure the orifices 112 allow air to flow through the plate 110, but they restrict the oil from doing so because of their small size and the relative difference in viscosity between oil and air. The air collects in a chamber 113 above the plate 110 until it is finally forced out of the restricted vent 106 and the amount of oil passing through the vent is limited even when pressure within the filter unit 10*a* gets abnormally high.

In its principal aspects, the filter device 10*a* functions in substantially the same manner as the filter unit 10. Oil to be filtered by the unit 10*a* enters the unit tangentially by an inlet 74 tangentially and flows into an annular space 108 surrounding the magnesium shell 99. As it swirls around within the housing 19*a* the centrifugal force created removes air bubbles as well as the larger solid particles which were suspended therein. The separated air passes through the orifices 112 of the plate 110 and is vented through the orifice fitting 106 at the upper end of the housing. Any solid particles in the incoming oil are collected in the bottom sump 89. The oil flowing under the lower edge of the shell 99 then enters the filter element 28*a*. When this primary element 28*a* of relatively fine filter media has become clogged, the pressure in the chamber 42*a* will reach a predetermined level and force the valve member 50*a* to open, thereby allowing flow through the element of coarser filter medium. If and when the latter also becomes clogged, the pressure of the oil within the housing 19*a* and in the areas 97 and 108 around the elements will reach a level that initiates total bypassing and oil is then able to pass upward from the area 108 through the openings 103 into the space 97 (see Fig. 4), and when the pressure therein is great enough to overcome the force of the spring 95 the bypass valve 38*a* will operate to allow oil to flow through the chambers 42*a* and 44*a* and out the outlet 75.

Either of the filtering units 10 or 10*a*, as described above, will provide a good filtering action for a long period because during normal operation all of the oil passes through only the element having a fine filtering medium. The flow through the secondary or coarse medium element commences only after the first element has become clogged or if the oil is too cold and viscous to pass through it. If any occasion arises where both elements are clogged and the oil pressure drop through the filter elements increases to some predetermined level, e.g. 8 or 9 psi, within the filter housing 19, the bypass valve 38 or 38*a* will then open and allow the incoming oil to recirculate directly into the oil outlet conduit.

A particular advantage in the operation of the filter lies in the fact that oil flows through the secondary filtering element having the coarser medium only when a precise predetermined pressure drop occurs through the first element having the finer medium. Therefore, by observing an oil pressure gauge indicating the appropriate pressure reading within the filter, an engine operator can determine exactly when the first fine media element is clogged and is no longer filtering, and when the second filter element commences to operate. When this happens there is ample time to change the entire filter device before complete bypassing occurs.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves within the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

WHAT WE CLAIM IS:—

1. A filtering unit comprising a first filter element of relatively fine filter material and a second filter element of relatively coarse filter material, and valve means so arranged as normally to control the fluid to be filtered to pass through the first element, and to pass fluid through the second element when the pressure-drop through the first element exceeds a predetermined value.

2. A filtering unit for a lubrication system comprising a housing having an inlet opening and an outlet opening for the material being filtered, a pair of filtering elements fixed within said housing, the first of said filtering elements being composed of a relatively fine filter medium and the second element being composed of a relatively coarse filter medium, and valve means normally preventing the flow of material being filtered through said second filtering element, said valve means being adapted to open in response to an increased resistance to flow through the said first filtering element.

3. A filtering unit as described in claim 1 or 2 wherein said filtering elements are annular in shape and arranged in axial alignment within said housing.

4. A filtering unit as described in claim 2 wherein the second filtering element is located at the end of the filtering unit farthest from the inlet opening.

5. A filtering unit as described in claim 4 including a bypass valve between said inlet and outlet openings, said bypass valve being adapted to open at a pressure within said housing greater than the pressure required to open said valve means.

6. A filtering unit as described in claim 1 or 2 wherein said filtering elements are

axially aligned in a parallel arrangement and are separated by an annular dividing member, said valve means being located in said dividing member.

7. A filtering unit as described in claim 6 wherein said valve in said dividing member includes a closure member covering a central opening in said dividing member when said valve is closed, and spring means normally urging said closure member against said dividing member to prevent the flow of material being filtered through the filtering element having the relatively coarse filter material, said closure member being adapted to move away from said dividing member to allow flow through said coarse filter material only when the pressure drop through the filtering element composed of a relatively fine filter material reaches a predetermined value.

8. A filtering unit as described in claim 1 or 2 wherein said filtering elements are enclosed within a filter cartridge mounted within said housing, said cartridge comprising a cylindrical shaped perforated outer wall member and an inner perforated wall member.

9. A filtering unit of claim 8 including an impervious end cap at one end of said cartridge and an annular end wall at the other end thereof adjacent the inlet to said housing.

10. A filtering unit of claim 9 including an annular dividing plate between said filtering elements in said cartridge, said valve means being normally closed and centrally located on said plate and adapted to open to provide flow through said relatively coarse filtering material when the fluid pressure within said housing reaches a predetermined value.

11. The unit of claim 9 wherein said inner perforated wall member includes a first cylindrical portion in contact with the relatively fine filter material and extending on one side of said divider plate forming a first central chamber within said fine filtering medium communicating with the outlet of the unit, and a second cylindrical portion in contact with the relatively coarse filter material and extending on the other side of said divider plate forming a second central chamber with said coarse filtering medium, said valve means being adapted to open when the pressure in said second chamber reaches a predetermined value.

12. A filtering unit as described in claim 3 wherein said first filtering element has a central cavity in communication with said outlet opening, said second filtering element being located axially adjacent said first filtering element, and having a cavity aligned with the central cavity of said first filtering element, said first filtering element being composed of a relatively fine filter medium enclosed in a knitted fabric cover and said second filtering element being composed of a relatively coarse filtering medium enclosed in a knitted fabric cover.

13. A filtering unit as described in claim 12 including an impervious annular plate separating said first and second filter elements, said valve means centrally located in said plate being normally closed to prevent the flow of material being filtered through the second filtering means and operable to open in response to an increased resistance to flow through the first filtering means, thereby allowing the material being filtered to pass through the second filtering means and out of said unit through said outlet.

14. A filtering unit of claim 12 including a cup-shaped end member covering the end of the said second filtering element and bypass valve means in said end member for allowing oil within said housing to pass axially through the centres of both filter elements to the unit outlet when they have both become clogged.

15. A filtering unit of claim 14 including a cylindrical shell member fixed at one end, to said end member and extending axially away from said end member in said housing and having the other end located near the end of said first filtering element remote from said second filtering element.

16. A filtering unit of claim 15 wherein said other end of said shell has an outwardly curved edge flange forming a restricted annular passage with said housing, and means forming a trap for solid particles located directly below said annular passage.

17. A filtering unit of claim 15 including an air vent fitting at the end of said housing adjacent to said second filtering element, and an internal plate extending across the upper end of said housing just below said air vent, said internal plate having a series of small spaced apart orifices to permit the flow of air toward said vent.

18. Filtering means constructed and adapted to operate substantially as described with reference to Figs. 1 and 2 of the accompanying drawings.

19. Filtering means constructed and adapted to operate substantially as described with reference to Figs. 3 and 4 of the accompanying drawings.

CLEVELAND AND JOHNSON,
Agents for the Applicants,
Chartered Patent Agents,
302/306, Bank Chambers,
329, High Holborn,
London, W.C.1.

Berwick-upon-Tweed: Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.—1966
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2 from which copies may be obtained

Fig. 1.

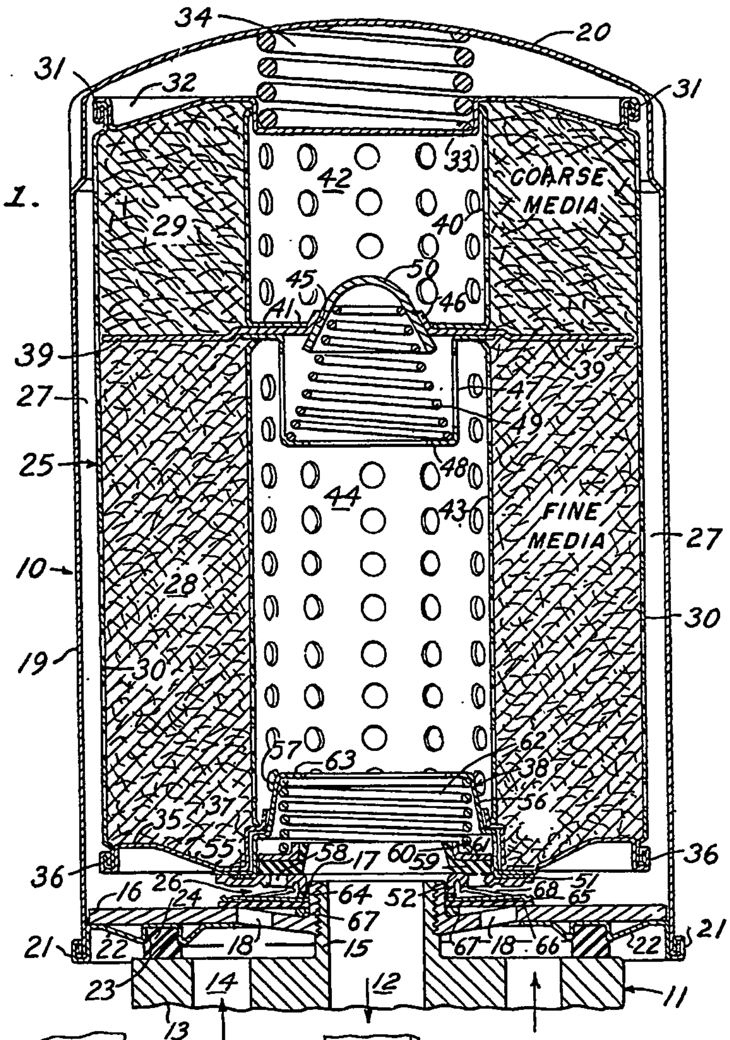
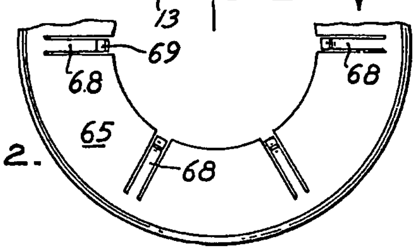


Fig. 2.



1,023,178 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

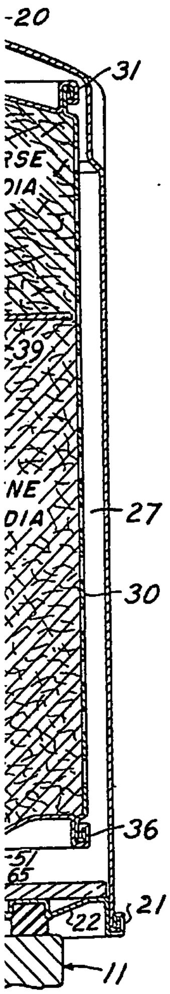


Fig.3.

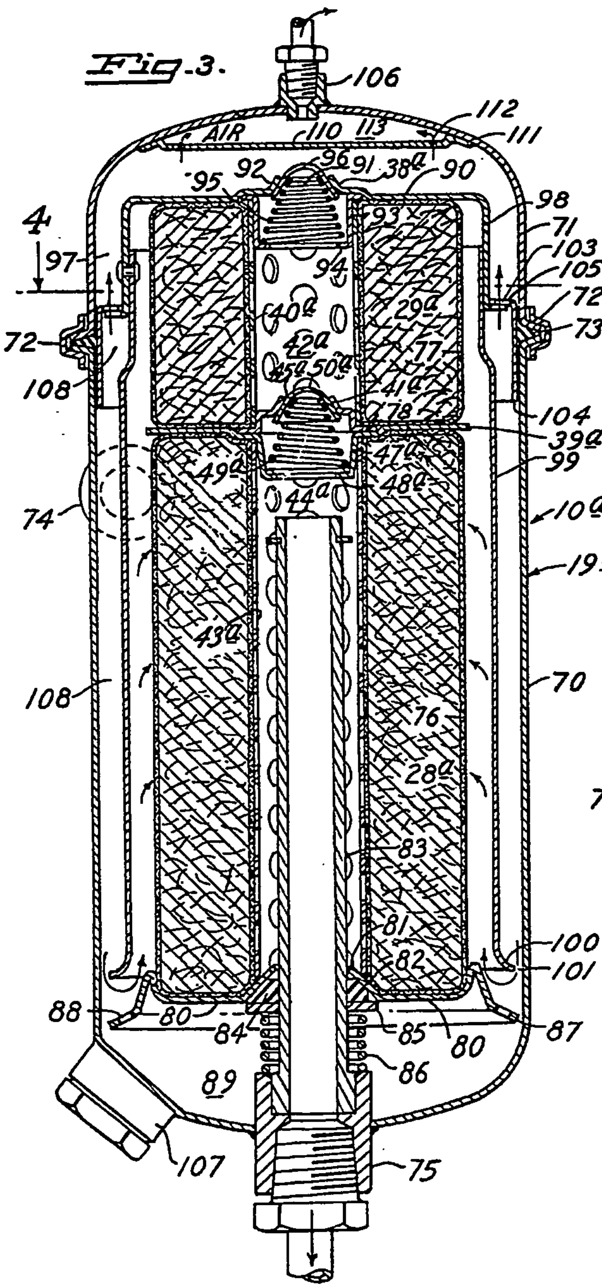
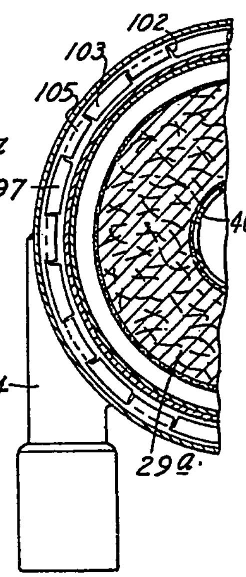
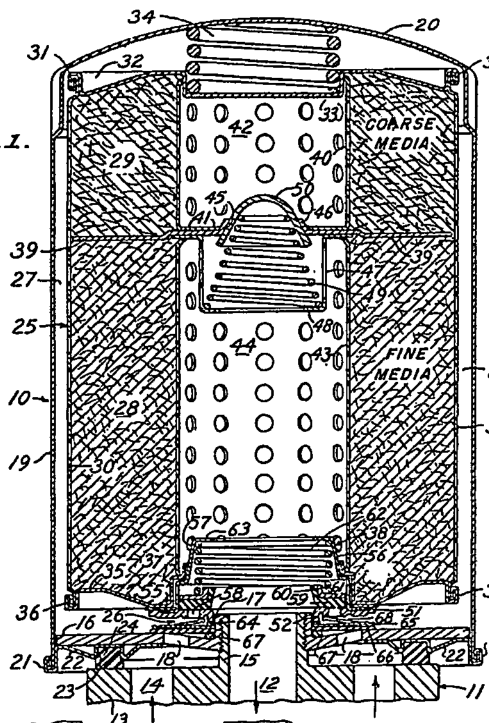


Fig.4.



1,023,178 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

Fig. 1.



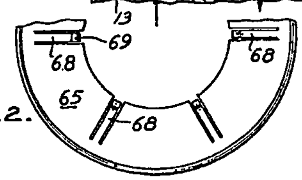


Fig. 2.

Fig. 3.

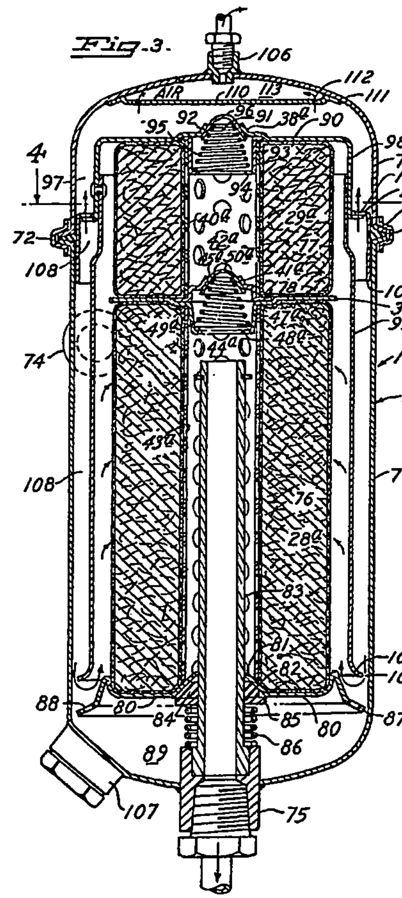


Fig. 4.